

Session:

Atmospheric Sciences

Title:

Assessment of polarization effect on efficiency of Levenberg-Marquardt algorithm in case of thin atmosphere over black surface

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Abstract:

The Levenberg-Marquardt algorithm [1, 2] provides a numerical iterative solution to the problem of minimization of a function over a space of its parameters. In our work, the Levenberg-Marquardt algorithm retrieves optical parameters of a thin (single scattering) plane parallel atmosphere irradiated by collimated infinitely wide monochromatic beam of light. Black ground surface is assumed. Computational accuracy, sensitivity to the initial guess and the presence of noise in the signal, and other properties of the algorithm are investigated in scalar (using intensity only) and vector (including polarization) modes.

We consider an atmosphere that contains a mixture of coarse and fine fractions. Following [3], the fractions are simulated using Henyey-Greenstein model. Though not realistic, this assumption is very convenient for tests [4, p.354]. In our case it yields analytical evaluation of Jacobian matrix. Assuming the MISR geometry of observation [5] as an example, the average scattering cosines and the ratio of coarse and fine fractions, the atmosphere optical depth, and the single scattering albedo, are the five parameters to be determined numerically. In our implementation of the algorithm, the system of five linear equations is solved using the fast Cramer's rule [6]. A simple subroutine developed by the authors, makes the algorithm independent from external libraries. All Fortran 90/95 codes discussed in the presentation will be available immediately after the meeting from sergey.v.korkin@nasa.gov by request.

1. Levenberg K, A method for the solution of certain non-linear problems in least squares, Quarterly of Applied Mathematics, 1944, V.2, P.164–168.
2. Marquardt D, An algorithm for least-squares estimation of nonlinear parameters, Journal on Applied Mathematics, 1963, V.11, N.2, P.431–441.
3. Hovenier JW, Multiple scattering of polarized light in planetary atmospheres. Astronomy and Astrophysics, 1971, V.13, P.7 – 29.
4. Mishchenko MI, Travis LD, and Lacis AA, Multiple scattering of light by particles, Cambridge: University Press, 2006.
5. <http://www-misr.jpl.nasa.gov/Mission/misrInstrument/>
6. Habgood K, Arel I, Revisiting Cramer's rule for solving dense linear systems, In: Proceedings of the 2010 Spring Simulation Multiconference, Paper No 82. ISBN: 978-1-4503-0069-8. DOI: 10.1145/1878537.1878623.